Effects of Harvest Date and Late-Summer Fertilization Rate on Stockpiled Bermudagrass Forage Mineral Concentrations

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Story in Brief

The objective of this experiment was to evaluate effects of harvest date and fertilization rate on macro and micro mineral concentrations of standing cured bermudagrass that had been stockpiled for winter grazing. Data were collected for two years at two locations, one each in eastern and central Oklahoma. Late summer fertilization was applied in mid-August at one of four levels (0, 30, 60, 120 lbs N/acre) and samples were harvested monthly beginning in November and continuing through March. Increasing rates of nitrogen fertilization increased the forage accumulation of macro minerals with the exception of calcium and phosphorus. However, increased N fertilizer was associated with reduced forage concentrations of iron, zinc and manganese while copper was not affected. Through the winter, forage concentrations of macro minerals declined, as did concentrations of iron, copper, and manganese. Phosphorus, potassium, magnesium, zinc, and copper should be incorporated into commercial feed and (or) mineral supplements for beef cows grazing stockpiled bermudagrass forage, particularly during late-winter.

Key Words: Stockpiled Bermudagrass, Minerals, Forage Quality, Fertilization

Introduction

Research has documented that applying N to bermudagrass during the summer growing season can increase forage yield and impact forage chemical composition (Lalman et al., 2000; Johnson et al., 2001). However, limited data is available regarding the impact of late summer N fertilization on micro and macro mineral composition of stockpiled bermudagrass throughout the winter grazing period. Therefore our objective was to evaluate the impact of rate of N fertilization and harvest date on the micro and macro mineral composition of stockpiled bermudagrass forage harvested during the late fall and winter.

Materials and Methods

This 2-yr experiment was conducted at two locations as a randomized complete block design with four replications. All plots (n=16) at the Eastern Research Station in Haskell, OK consisted of common bermudagrass and were situated on Taloka silt loam soil. All plots (n=16) at the Stillwater Agronomy Research Station in Stillwater, OK consisted of Greenfield bermudagrass and were situated on Norge loam soil. Spring fertilization was applied to all plots at both locations, at the rate of 100 lb N/acre and P and K were applied according to soil test recommendations. Hay was harvested in early June and early August to stage the plots for the experimentation period. Herbicide was applied to maintain a bermudagrass monoculture. Nitrogen fertilization treatments were applied on approximately August 17 at four levels: 0, 30, 60, and 120 lb N/acre. A 2 ft^2 area was hand clipped (5 cm stubble height) from each plot at the beginning of each month (November through March).

With the exception of sulfur, mineral concentrations were determined using an inductively coupled plasma radial spectrometer (ICP). Sulfur concentration was determined using the combustion method (Leco, model SC-432).

Data were analyzed using least squares analysis of variance and effects in the model included fertilization rate, harvest date, and the interaction. Effects of year, location, and replication were considered random. Polynomial contrasts were conducted to evaluate the effects of fertilization rate and harvest date.

Results and Discussion

Macro Minerals. Fall forage accumulation and forage carbohydrate and protein fractions from this experiment are presented in Johnson et al., 2002. Fertilization rate did not significantly alter forage concentrations of calcium and phosphorus (Table 1). However, concentrations of calcium and phosphorus declined from November through January and stabilized from January through March (linear and quadratic effects $P<.01$).

Increasing rates of N fertilizer increased (linear effect $P<.01$) concentrations of magnesium, potassium, sodium and sulfur (Tables 1 and 2) in forage, especially during the fall. As a result, higher rates of N fertilizer were associated with a more rapid decline in these elements as the winter progressed (interaction $P<.01$ and linear and quadratic effects of harvest date $P<.01$).

Forage calcium and sulfur concentrations remained above, and sodium concentration remained well below the suggested requirements for beef cattle (NRC, 1996) throughout the winter. Forage phosphorus, magnesium and potassium would be expected to meet the requirements of most classes of beef cattle during November although these minerals would require supplementation for most classes of cattle from December through March. Mineral requirements for beef cattle (NRC, 1996) were developed using constant mineral digestibility values. It should be recognized that the effects of N fertilization rate and harvest date on forage mineral digestibility are not known and that these effects could alter mineral supplementation recommendations.

Table 1. Effect of fertilization rate and harvest date on calcium, phosphorus, and magnesium concentrations in stockpiled bermudagrass forage (expressed as a percentage of dry matter)

	Harvest Date							
Component	November	December	January	February	March	SE	Fert[a]	Date[a]
Calcium[H]							--	L,Q
0	.53	.41	.38	.40	.41	.14		
30	.54	.42	.39	.41	.42	.14		
60	.53	.42	.38	.40	.41	.14		
120	.54	.43	.38	.39	.39	.14		
Phosphorus[H]							--	L,Q
0	.21	.17	.13	.12	.12	.03		
30	.21	.18	.14	.13	.13	.03		
60	.21	.19	.15	.14	.13	.03		
120	.23	.20	.16	.15	.15	.03		

Magnesium[F,H,X]							L	L,Q
0	.130	.101	.075	.067	.067	.036		
30	.141	.109	.082	.076	.072	.036		
60	.155	.122	.089	.082	.078	.036		
120	.193	.154	.108	.097	.092	.036		

[a]Contrasts significant at the P<.05 level: L = linear, Q = quadratic

[FHX]Significance in model at the P<.05 level: F = fertilization rate, H = harvest date, X = fertilization by harvest date interaction

Table 2. Effect of fertilization rate and harvest date on potassium, sodium, and sulfur concentrations in stockpiled bermudagrass forage (expressed as a percentage of dry matter)

	Harvest Date							
Component	November	December	January	February	March	SE	Fert[a]	Date[a]
Potassium[F,H,X]							L	L,Q
0	.58	.37	.20	.15	.15	.07		
30	.67	.43	.23	.19	.16	.07		
60	.80	.46	.27	.19	.17	.07		
120	.91	.55	.32	.23	.21	.07		
Sodium[F, H,X]							L	L,Q
0	.015	.008	.006	.002	.004	.008		
30	.018	.014	.006	.005	.005	.008		
60	.024	.015	.008	.004	.005	.008		
120	.037	.029	.011	.008	.008	.008		
Sulfur[H,X]							L	L
0	.20	.19	.20	.19	.19	.03		
30	.23	.21	.21	.20	.20	.03		
60	.26	.23	.23	.21	.20	.03		
120	.29	.25	.24	.21	.22	.03		

[a]Contrasts significant at the P<.05 level: L = linear, Q = quadratic

[FHX]Significance in model at the P<.05 level: F = fertilization rate, H = harvest date, X = fertilization by harvest date interaction

Micro minerals. There was a tendency for increased rates of N fertilizer to dilute the stockpiled bermudagrass forage concentrations of iron, zinc and manganese (linear effect P<.05; Table 3). Copper and molybdenum concentrations were not affected by rate of N fertilizer.

Forage zinc concentration slightly increased over time, although this increase of around 5% is not considered to be biologically significant. Molybdenum concentration was not affected by harvest date. Concentrations of iron, copper and manganese declined by 42, 20, and 16%, respectively, from November through March.

Forage zinc and copper concentrations were below the recommended dietary concentration for beef cattle (NRC, 1996), while concentrations of manganese, iron and sulfur would be expected to meet the minimum requirements recommended for beef cattle (NRC, 1996). Molybdenum has been identified as an antagonist to the absorption of copper and a minimum dietary ratio of 6:1 copper to molybdenum is recommended (NRC, 1996). However, in this experiment, the copper to molybdenum ratio remained above 10:1. This suggests that copper would not need to be supplemented beyond the recommended dietary concentration to offset the potential antagonistic effect of molybdenum.

Table 3. Effect of fertilization rate and harvest date on micro mineral concentrations in stockpiled bermudagrass forage (expressed as parts per million)

	Harvest Date							
Component	November	December	January	February	March	SE	Fert[a]	Date[a]
Iron[F,H]							L	L,Q
0	599	272	306	442	351	205		
30	580	198	287	416	351	205		
60	500	176	238	321	301	205		
120	507	166	212	271	287	205		
Zinc[H,X]							L	L,Q
0	21.0	23.3	24.8	24.2	23.7	4.6		
30	20.4	22.9	23.6	23.3	24.5	4.6		
60	20.6	21.9	22.4	22.6	22.2	4.6		
120	19.4	18.4	19.5	19.5	20.4	4.6		
Copper[H]							--	L,Q
0	4.22	4.04	3.77	3.93	3.56	1.14		
30	4.31	3.96	3.78	3.61	3.67	1.14		
60	4.39	4.21	3.63	3.67	3.54	1.14		
120	4.82	4.08	3.72	3.92	3.62	1.14		
Manganese[H]							L	L,Q
0	153	121	118	119	118	29		
30	140	111	110	116	114	29		
60	127	104	101	106	114	29		
120	120	96	98	102	101	29		
Molybdenum[H]							--	L
0	.45	.45	.45	.46	.39	.05		
30	.44	.44	.43	.47	.38	.05		
60	.43	.43	.44	.39	.36	.05		
120	.44	.41	.44	.35	.37	.05		

[a]Contrasts significant at the $P<.05$ level: L = linear, Q = quadratic

[FHX]Significance in model at the $P<.05$ level: F = fertilization rate, H = harvest date, X = fertilization by harvest date interaction

Implications

Under these conditions, increasing rates of nitrogen fertilization increases the forage accumulation of macro minerals with the exception of calcium and phosphorus. Conversely, increased rates of N fertilizer reduced forage concentrations of iron, zinc and manganese while copper was not affected. Through the winter, forage concentrations of macro minerals declined as did concentrations of iron, copper and manganese. In general, phosphorus, potassium, magnesium, zinc, and copper should be incorporated into commercial feed and (or) mineral supplements for beef cows grazing stockpiled bermudagrass forage, particularly during late-winter.

Literature Cited

NRC, 1996. Nutrient Requirements for Beef Cattle. NAT Academy., Press, Washington, D.C.
